OUTLOOK FOR URANIUM

focus

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Outlook for Uranium

The appearance in 1945 of a new fuel, atomic energy, several million times more concentrated than any hitherto known to man, inaugurated a new era in the world's history—an era in which bewilderment, awe, and near-panic seem to be our common fare. In learned and popular articles and books, newspapermen, scientists, businessmen, philosophers, politicians, religious leaders, doctors, and a host of others have bombarded us with startling and often contradictory statements and opinions that most of us are ill-equipped to evaluate and understand. Visions of cheap, easily available energy have prompted extravagant predictions and raised the hopes of millions in the so-called underdeveloped lands who are seeking and demanding a better life. And at the same time the threat of contaminated food, air, and water from radioactive fallout and even annihilation in an atomic war have made ardent pacifists of millions of former sword-rattlers.

URANIUM, the major source of this new fuel, has a metallic appearance, is ductile and malleable, and can be made into rods or wires or sheets. Its refinement and fabrication (we are here concerned only with the peaceful uses of atomic energy) are complicated operations rendered more difficult than many other similar processes by the ever-present danger of explosion and radiation. In order to prevent such, the chain reaction, which produces the heat for nuclear power and which can cause an explosion, must be kept under control. Control of the chain reaction is achieved by keeping constant the number of neutrons present. In a typical reactor (there are many variations in this basic type), this is accomplished by using substances known as moderators, such as graphite and water, which reduce the speed of fast neutrons, and by inserting rods of a material capable of absorbing neutrons, such as cadmium or boron. The addition or removal of the absorbent rods controls the rate of reaction, and thus the heat generated. A liquid or gas circulated through or around the reactant mass extracts the heat, which then goes to an ordinary steam generator used to make electricity.

KNOWN RESERVES. Uranium is a major constituent of about 100 types of mineral and is almost as plentiful in the earth's crust as lead or zinc, but there are few places where the concentration is sufficiently rich to justify exploitation. Deposits in Belgian Congo and Canada range between 1 and 4 per cent uranium; those in the United States, Australia, Portugal, and elsewhere average between

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0.1 and 1 per cent; in South Africa ores of 0.02 per cent are mined as a by-product of the gold industry. It was estimated in 1957 that Free World reserves of developed or partly developed commercial uranium ore contained over 1 million tons of uranium (U_3O_8): 380,000 tons in Canada; 370,000 in the Union of South Africa; 205,500 in the United States; more than 100,000 in France; and 1,000 in the Rum Jungle area of northwestern Australia. Data on reserves in Belgian Congo, Portugal, other areas of Australia, the Soviet Bloc countries, and other countries are not available.

Sixty-eight percent of the reserves in the United States are in New Mexico, 8 per cent in Utah, 8 per cent in Wyoming, and 4.7 per cent in Colorado. The uranium boom that hit the Colorado Plateau during the last decade resembled in many ways the gold rushes of earlier days. Impelled by a desire for quick riches, thousands of professional and amateur miners flocked in, and roamed the countryside, geiger counter in hand. Quiet villages were transformed overnight into roaring towns, with the usual accompanying shortages of housing, water supply, and sewage disposal. But today the adventurous private prospector is giving way to the large company which can carry on aerial surveys, drilling, and geological study; for the present cost of locating a deposit usually reaches $20,000 to $50,000, and occasionally much more.

Because of the low quality of the ore (about 0.27 per cent on the average), the processing mills are rather small and are located as close to the mines as feasible. If the existing mills continue to operate at the same rates as in 1957, the known reserves will last only about 20 years, and in 1958 the Federal government terminated its policy of buying all uranium produced and thus brought further exploration virtually to a halt. The negotiation of new contracts to purchase uranium was ended because of the possibility of "serious overproduction which might occur if very large additional uranium discoveries were made." However, the government is honoring contracts previously signed and is continuing to pay $8 per pound of uranium.

In view of this limited buying program, it is quite possible that the United States will drop from first to second place, after Canada, in the production of uranium, or even to third place, after the Union of South Africa.

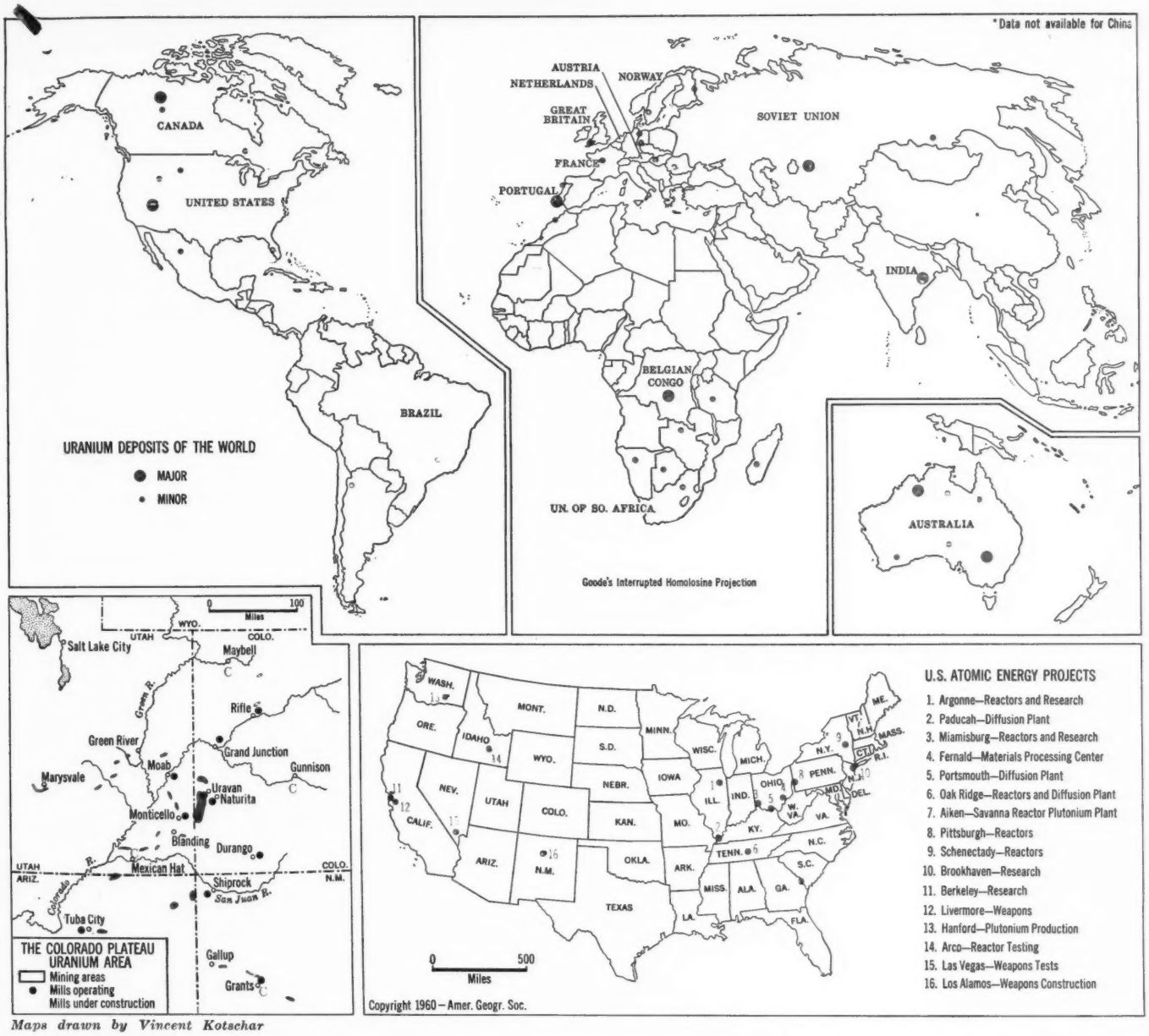
Nevertheless, the size of the overall investment in the atomic industry, both public and private, suggests that big business has confidence in its future. It has been termed "a young octopus with tentacles that branch out all over the American industrial map." Today it directly supports 135,000 people, and, indirectly, 700,000 others.

Most of the nation's mining concerns have active interests in the business, and some of the large ones have very large interests indeed. Anaconda, for instance, has, in New Mexico, America's biggest mine, containing 15 million tons of 0.16 per cent ore. The total private investment in uranium mills is more than $75 million and, besides the existing projects shown on the accompanying map of the United States, there are several new ones under construction.

COSTS, of course, will be an all important factor in the future of atomic reactors. Research is extremely expensive, and construction is more expensive than for conventional plants. The Shippingport atomic plant (near Pittsburgh, Pa.), for example, which cost $121 million in 1957, could probably be built for half to two-thirds that price today since a large portion of that cost was for research. In a conventional power plant, one-third of the costs are capital charges and two-thirds are operational; in a nuclear power plant these figures are more than reversed.

When the Shippingport plant was built, electricity cost about 64 mills (6.4 cents) per kilowatt-hour, whereas nearby coal-fired plants could produce for 8 mills per kilowatt-hour. However, new techniques and new types of nuclear reactors are reducing costs. In 1956 an experimental Boiling Water Reactor was producing electricity at 52 mills per kilowatt-hour; costs are now down to 29 mills. Another plant, under construction in northwestern Massachusetts, may be able to produce at 13 mills per kilowatt-hour. A gas cooled nuclear reactor being built in southeastern Pennsylvania is expected to "show the way to short-cuts that will lead to economical, 300,000-kilowatt nuclear power plants."

The United States as a whole, with its large deposits of coal, oil, and natural gas, will probably find it cheaper to produce power in conventional plants for several years to come. But there are parts of the country, such as the six New England states, where the cost of fossil fuels has risen rapidly in the past two decades and power costs are now



Maps drawn by Vincent Kotschar

59 per cent above the national average. Electric power costs four times as much in New York City, for instance, as it does in Seattle. In such areas of high fuel costs, nuclear power may indeed become an economic possibility within the next seven or eight years.

In such countries as Great Britain, Austria, France, and Brazil, the time is certainly not too far distant when atomic power will be able to compete with coal in costs. The Calder Hall plant in Great Britain, for example, produces electricity as a by-product at only about ten per cent more per kilowatt-hour than the conventional plants.

THE DANGEROUS WASTES. Another all important factor in the future of atomic energy is the disposal of radioactive wastes. At Hanford, Wash., 50 million gallons of waste material have been carefully filtered, pumped into large iron tanks, and buried. In addition, almost 4 billion gallons of low- and intermediate-level wastes have been dumped into trenches. The tank method may be satisfactory in certain climates where external rusting is slow, but in any case the staggering cost of the tanks, amounting to 41 cents per gallon of waste at Hanford, would be too expensive for the immense amounts of waste that will presumably be

produced in larger and more numerous power plants. At least six hundred years are required for the wastes to cease radioactivity.

Other methods of waste disposal are being tried. At Calder Hall, the use of natural uranium, U-238, instead of the more radioactive U-235 (which is used in the United States), makes the disposal problem somewhat less troublesome. Wastes are pumped two miles out into the ocean and discharged into deep basins. It is hoped they will become relatively harmless as they gradually mix with other sea water. However, the Soviet government has become alarmed at this procedure and has protested. Recent discoveries concerning deep ocean currents also would seem to make the practice unwise. At the 1958 International Conference on the Peaceful Uses of Atomic Energy, held in Geneva, the Netherlands, which also has been dumping atomic wastes in the sea, asked western European nations to set up international regulations and safety standards. The United States has recently cut its price of radioactive isotopes from $500 per unit to $5 in the hope of disposing of some to industry and also ridding itself of the wastes. Disposal of wastes will probably be a key factor in atomic reactor locations.

AT THE MOMENT, it is only in countries already equipped with surplus capital, highly trained scientists, a large group of skilled workers, and a sophisticated industrial economy, that atomic power can be developed. It is obvious, therefore, that the present pre-eminent industrial areas of the world will remain so for the time being, and that major relocations will not take place because of a change of fuel. Since one pound of uranium will produce as much energy as 1,300 tons of coal or 6,000 barrels of oil, it is equally obvious that the nations most interested in developing atomic energy are those suffering from a shortage of coal and/or oil and those in which these fuels are expensive. In Great Britain, which spends more than £440 million a year on imported fuel, and where the cost of domestic coal is rising, the immediate need for nuclear power has stimulated a more intensive development of industrial reactors than in any other country. At Calder Hall, for instance, only 165 pounds of uranium are required annually to run the installation; about 5,000 carloads of coal would be needed to produce the same amount of power if the plant were of the conventional type. In 1958, coal was selling at the mine at $5.50 per ton in the United States, whereas it cost $16 in Norway and $23.50 in Austria.

PRODUCTION. The military requirements of the four nations in possession of the atomic bomb, the United States, the Soviet Union, Great Britain, and, now, France, as mentioned, do not here concern us. Such requirements are naturally secret, and in any case change so rapidly that an accurate estimate one day may be worthless the next. It should be noted, however, that bombs are made from plutonium, which is a by-product of atomic power reactors. The United States government is merely leasing uranium to the company at Shippingport and obtains the plutonium produced. Incidentally, plutonium can also be used in a reactor to produce power. The United States is now building such a plant at Hanford, and Great Britain has an experimental one of this type at Dounreay in Scotland.

On the peaceful level, there has been increasing cooperation between nations in the development and utilization of atomic energy. The Geneva conference mentioned above was attended by more than 6,000 people from 69 nations. The European Atomic Energy Community (Euratom) came into existence also in 1958. This consists of Belgium, France, Western Germany, Italy, Luxembourg, and

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the Netherlands, which have entered into an agreement with the United States in an atomic power program under which 1 million kilowatts of atomic electric generating capacity will be installed in the Euratom countries by 1963. The program is being financed by a long-term, low-interest loan from the United States Export-Import Bank.

The 17-member Organization for European Economic Cooperation (O.E.E.C.) established a European Nuclear Energy Agency, in Paris, to promote cooperative atomic projects. One of those under way is a plant at Mol, Belgium, for the chemical processing of used reactor fuel elements; another is a nuclear reactor at Halden, Norway, to produce 10,000 thermal kilowatts of heat in the form of steam for a pulp and paper mill.

Other agencies active in promoting the development of atomic energy are the International Atomic Energy Agency, and the International Bank for Reconstruction and Development, which has negotiated a loan to Italy for construction of a 150,000 electrical kilowatt atomic power plant at Punta Fiume, between Rome and Naples. Under bilateral agreements, United States manufacturers are building some of these reactors, and also one for a plant in Kahl, Western Germany. Canada is helping to build a test reactor in Bombay, India.

Several countries are turning to Great Britain rather than to the United States for atomic power equipment, because British reactors are made to run on U-238 as it comes from the mill, whereas the American ones use U-235 which occurs as one part in 139 in natural uranium and must be separated by an expensive process.

The Soviet Union says it is assisting in the construction of a 150,000 electrical kilowatt atomic power plant in Czechoslovakia, and that Soviet reactors have been supplied to Eastern Germany, Poland, Rumania, and Communist China, and others are being built in Yugoslavia, Bulgaria, Hungary, and the United Arab Republic.

In 1957 the major producers of U_3O_8 concentrate were the United States, 10,000 tons; Canada, 7,000; Union of South Africa, 5,500; Belgian Congo,

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